INTERNATIONAL ROUND TABLE ON MATERIALS CRITICALITY (IRTC)

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ESM Foundation, Switzerland
About IRTC

- IRTC is an international “Round Table” project on approaches towards assessing materials criticality, taking place in the form of workshops at international conferences.
- The results are consecutively published in the form of scientific papers.
- The project shall advance the research in criticality assessment, foster international exchange and education in the topic, identify common ground and differences, and raise awareness towards materials criticality, especially in industry.
- It shall also lay the cornerstone for a long-lasting network of internationally leading experts.
Project partners

- **Gian Andrea Blengini**, Joint Research Center, European Commission
- **Wei-Qiang Chen**, Chinese Academy of Sciences
- **Jo Dewulf**, University of Gent, Belgium
- **Roderick Eggert**, Colorado School of Mines and the Critical Materials Institute, USA
- **Tom Graedel**, Yale University, USA
- **Christian Hagelüken**, ESM Foundation, Switzerland, and Umicore, Germany
- **Atsufumi Hirohata**, University of York, GB
- **Komal Habib**, University of Waterloo, Canada
- **Alan J. Hurd**, Los Alamos National Laboratory, USA
- **Gang Liu**, University of Southern Denmark
- **René Kleijn**, University of Leiden, Netherlands
- **Maïté Le Gleuher**, The French Geological Survey BRGM, France
- **Min-Ha Lee**, Korea Institute of Industrial Technology (KITECH)
- **Gavin Mudd**, Royal Melbourne Institute of Technology, Australia
- **Keisuke Nansai**, National Institute for Environmental Studies, Tsukuba, Japan
- **Nedal Nassar**, US Geological Survey
- **David Peck**, Delft Technical University, Netherlands
- **Armin Reller**, ESM Foundation, Switzerland, and University of Augsburg, Germany
- **Dieuwertje Schrijvers**, University of Bordeaux, France
- **Guido Sonnemann**, University of Bordeaux, France
- **Luis Tercero**, Fraunhofer ISI, Germany
- **Ester van der Voet**, University of Leiden, Netherlands
- **Patrick Wäger**, Swiss Federal Laboratories for Materials Science and Technology Empa, Switzerland
- **Steven B. Young**, University of Waterloo, Canada
Advisory Board

- **Aleff Group, UK**: Dr Julian Hilton, Chairman
- **Ames Laboratory, USA**: Dr Mark Christopher Haase, Director Critical Materials Institute
- **The British Geological Survey, UK**: Mr Gus Gunn, Principal Economic Geologist, and Dr Evi Petavratzi, Senior Mineral Commodity Geologist
- **CIRCE institute, University of Zaragoza, Spain**: Dr Alicia Valero, Head of Industrial Ecology Group
- **Cobalt Institute**: Ms Carol-lynne Pettit, Sustainability Manager
- **DMT GmbH & Co KG, Germany**: Dr Michael Haschke, Manager R&D
- **Federation of European Materials Societies FEMS**: Dr Orlando Rios, Lead Focus Area Raw Materials
- **Granta Design Ltd., Great Britain**: Dr Tatiana Vakhitova, Sustainability Consultant, and Dr James Goddin, Market Development Manager
- **German Environment Agency (UBA)**: Mr Jan Kosmol, Research and Policy Officer, and Dr Philipp Nuss, Scientific Officer
- **Grundfos Holding S/A, Denmark**: Dr Ernst Lutz, Group Executive Vice President
- **Heraeus Deutschland GmbH & Co. KG, Germany**: Dr Hans Jürgen Wachter, Executive Vice President
- **International Raw Materials Observatory INTRAW**: Mr Vitor Correia, Secretary General
- **Japan Oil, Gas and Metals National Corporation JOGMEC, Japan**: Mr Daisuke Ariga, Member of Strategic Metals Research Team
- **Ministry of Economic Affairs, Labour and Housing Baden-Württemberg, Germany**: Mr Günther Leßnerkraus, Director
- **Ministry of Trade, Industry and Energy, Korea**: Mr Taegyu Park, Deputy Director of Metals & Chemicals Division
- **National Institute for Clean-and-Low-Carbon Energy, China**: Dr Anthony Ku, Director of Advanced Technologies
- **Swiss Academy of Engineering Sciences SATW, Switzerland**: Dr Xaver Edelmann, Full Member SATW and Head Topical Platform Resources and Sustainability, and Dr Margarethe Hofmann, Full Member SATW
- **Swissmem - Swiss association of mechanical and electrical engineering industries, Switzerland**: Dr Jean-Philippe Kohl, Head of Economic Policy, and Dr Christine Roth, Manager Environment
- **Technische Universität Berlin, Chair of Sustainable Engineering**: Dr Vanessa Bach, Researcher
- **United Nations Economic Commission for Europe, UNECE**: Mr Harikrishnan Tulsidas, Economic Affairs Officer
- **US Department of Energy**: Mr Fletcher Fields, Economist
- **WeLoop, France**: Dr Naeem Adibi, Managing Director
- **World Resources Forum Association, Switzerland**: Dr Mathias Schlupe, Program Director
Project Timeline

How methodology determines what is critical

Criticality & Circular Economy

How industry manages criticality

In-use stock and secondary supply of CRM

Criticality in policy-making: where are we today?

<table>
<thead>
<tr>
<th>2018</th>
<th>2019</th>
<th>2020</th>
</tr>
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<tbody>
<tr>
<td>June 2018:</td>
<td>Oct 2018:</td>
<td>June 2019:</td>
</tr>
<tr>
<td>Round Table</td>
<td>Round Table</td>
<td>Round Table</td>
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<tr>
<td>Vancouver</td>
<td>Tokyo</td>
<td>Beijing</td>
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<td></td>
<td>March 2019:</td>
<td>Nov 2019:</td>
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<tr>
<td></td>
<td>Round Table</td>
<td>Round Table</td>
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<td></td>
<td>Texas</td>
<td>Brussels</td>
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</tbody>
</table>
1st Round Table at RFG2018 in Vancouver, June 17: “How methodology determines what is critical”
### First Round Table: Presenting & comparing different methodologies

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
<th>Presenter/Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>13:50</td>
<td>Stimulus presentation <strong>NRC</strong> methodology</td>
<td>Rod Eggert, CMI / Colorado School of Mines</td>
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<tr>
<td>14:00</td>
<td>Stimulus presentation <strong>Yale</strong> methodology</td>
<td>Tom Graedel, Yale University</td>
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<tr>
<td>14:10</td>
<td>Stimulus presentation <strong>USGS</strong> methodology</td>
<td>Nedal Nassar, USGS</td>
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<tr>
<td>14:20</td>
<td>Stimulus presentation <strong>EU</strong> methodology</td>
<td>Milan Grohol, European Commission</td>
</tr>
<tr>
<td>14:30</td>
<td>Stimulus presentation <strong>Augsburg</strong> methodology</td>
<td>Andrea Thorenz, University of Augsburg</td>
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<tr>
<td>14:40</td>
<td>Stimulus presentation <strong>Granta</strong> methodology</td>
<td>James Goddin, Granta Design (remotely)</td>
</tr>
<tr>
<td>14:50</td>
<td>Stimulus presentation <strong>KIRAM / KITECH</strong> methodology</td>
<td>Min-Ha Lee, KITECH</td>
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<td>15:00</td>
<td><strong>Coffee Break</strong></td>
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<tr>
<td>15:30</td>
<td><strong>Round Table Discussion</strong></td>
<td>Round Table</td>
</tr>
<tr>
<td>16:30</td>
<td><strong>Round Table Discussion including audience</strong></td>
<td>All</td>
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</tbody>
</table>
... in a common format

- Slide 1: Intro
  Name of presenter and methodology, year when the methodology was first developed/introduced

- Slide 2: Goal and Scope
  Short introduction of the system boundaries of the methodology, if applicable: development over time (e.g. different “releases”, refinements or foci)

- Slide 3: Scope explanation
  Observed materials and explanation of choices

- Slide 4: Factor explanation
  Factors for criticality and explanation of choices

- Slide 5: Aggregation
  Aggregation of factors (how do the factors combine into an assessment) – justification

- Slide 6: Unique features
  Specificities and major differences to other methodologies

- Slide 7: Results and implications
  What where the results, have they been used, if yes: where and for what (in politics, science, industry?), what was the feedback, have there been consequences/measures as a result?

- Slide 8: Limitations
  Limitations of the methodology and the results (e.g. lack of data, uncertainty, insufficient representation of indicators for what was aimed to be assessed)

- Slide 9: Outlook
  Further steps to be taken (e.g. applications, further development, follow-up methodologies)
“How methodology determines what is critical”

Structured description of renown methods (20+ so far)
<table>
<thead>
<tr>
<th>Method developer</th>
<th>Yale, US (company)</th>
<th>NSTC, US</th>
<th>EU</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>5 Indicators I</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Indicators from which area are used? (E.g. geological, technical, environmental, economic considerations, …)</td>
<td>Geological, technical, economic, environmental, social, geopolitical</td>
<td>The indicators represent indirectly geological, technical, environmental, and economic considerations.</td>
<td>Economic, technical, political</td>
</tr>
<tr>
<td>b. Justification of main indicators and factors</td>
<td>Exclusion of short-term factors such as economic fluctuations, natural disasters, rapid changes in production, etc (Graedel2015)</td>
<td>Each indicator provides different and counter balancing aspect. The selection of indicators is influenced by the applicability across the entire suite of minerals being investigated, and therefore represents the “lowest-common” indicators due to data constraints for some minerals. Transparency and repeatability are indicator selection criteria.</td>
<td>Indicators are as much as possible methods (2011 and 2014), in order to achieve the highest possible policy relevance, in the international domain, regarding changing policy priorities and research actions. Indicator selection is also influenced by data availability.</td>
</tr>
<tr>
<td><strong>6 Indicators II</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. To what extent are the indicators forward looking?</td>
<td>Not at all, except estimated future demand statistics to calculate depletion time</td>
<td>Indirectly</td>
<td>Not</td>
</tr>
<tr>
<td>b. Are the indicators quantitative and following objective measurement procedures?</td>
<td>Data are both quantitative and following objective measurement procedures. The final scores are transformed to a 0-100 scale, using different transformation methods for different indicators. Scores are weighted-averaged by a country's mine production. Details are in our publications.</td>
<td>Quantitative</td>
<td>Indicators are quantitative and following objective measurements. The integration of data is based on expert judgment. WGI is quantitative but based on subjective judgment.</td>
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<tr>
<td>c. What is the role of expert judgment and how expert judgment implemented in the results?</td>
<td>Indicators that cannot be valued using objective data are scored in an ordinal manner with the values 12.5, 37.5, 62.5, and 87.5 with uncertainty ranges of +/- 12.5.</td>
<td>Mostly from USGS published information, although some information is withheld</td>
<td>Public institutions, expert consultants</td>
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<tr>
<td>d. What are the data sources: from public institutions only? Research reports? Industry data?</td>
<td>Data sources are: anything we can find - public, private, expert opinion, etc.</td>
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</table>
Questions cover e.g.:

Who uses which data?

Which method creates which results for which element?
2nd Round Table at EcoBalance in Tokyo, October 9: “Criticality and Circular Economy”
Criticality and Circular Economy

IRTC Round Table in Tokyo on “Criticality and the Circular Economy”, October 9, 2018

The International Round Table on Materials Criticality, IRTC (www.irtc.info), is an internationalization project funded by EIT Raw Materials which runs from April 2018 to March 2020. The project aims at advancing criticality assessment on a global level. In four Round Table workshops and joint publications, research on differences and commonalities of different approaches on criticality as well as considerations about its implementation in industry and policy-making shall be fostered and advanced. Awareness towards materials criticality, and its crucial role for a circular economy, shall be raised by creating visibility at established conferences with a diverse audience and high impact in research and industry. A first Round Table took place as a side event of the „Resources for Future Generations” conference on June 19, 2018 in Vancouver, Canada, with the title „How methodology determines what is critical”.

The second International Round Table on Materials Criticality took place on October 9, 2018 in the context of the Ecobalance conference in Tokyo, Japan. The title of the second Round Table was “Criticality and the Circular Economy”. After a welcome from Keisuke Nansai (NIES), the concepts of the Circular Economy, the Sustainable Development Goals, and social implications of resource extraction were introduced by Ester van der Voet (Leiden University), Guido Sonnemann (University of Bordeaux), and David Sussman (New York University), respectively. Furthermore, several speakers were invited to give more insight into the Japanese, Korean, and Chinese perspectives on material criticality and the Circular Economy. Kotaro Shimizu (Mitsubishi) presented the Japanese strategy on the procurement of mineral resources from a...
Next steps

• Proceeding with publications

• Holding Round Table and conducting an industry survey at the 3rd Round Table at the TMS Annual Conference in San Antonio, Texas, on March 2019, to establish an overview on awareness on, and perception of, criticality in industry

• Use this for the publication “How industry manages criticality” as well as for further development of a “Criticality decision tree” to provide practical guidance in criticality assessment
Next next steps

• Round Table in Beijing on secondary sourcing and material flows
• Closing event at the Raw Materials Week in Brussels 2019: comparing industry awareness with existing policies
• Follow-up proposal planned for 2020-2022 with a focus on application in industry
Join the discussion

• Become a member of the project’s Advisory Board
• Join our “Slack Channel”
• Add to the open methodology table if applicable
• Join us in Texas, Beijing or Brussels 2019
• Join the industry focus group

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